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(54) **COMBINED HYBRID AUTOMATIC RETRANSMISSION REQUEST SCHEME**

KOMBINIERTES HYBRIDES SCHEMA ZUR AUFORDERUNG AUTOMATISCHER
ÜBERTRAGUNGSWIEDERHOLUNG

LOGIQUE COMBINEE POUR DEMANDES DE RETRANSMISSION AUTOMATIQUE HYBRIDES

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention generally related to error handling in the field of communication systems and, more particularly to error handling using forward error correction (FEC), automatic retransmission requests (ARQ) and variable redundancy in digital communication systems.

[0002] Reference is made to a related application, "Method and System for Measurement Based Automatic Retransmission Request in a Radiocommunication System" which was published as U.S. Patent Application US 2001/0056560.

[0003] The growth of commercial communication systems and, in particular, the explosive growth of cellular radiotelephone systems, have compelled system designers to search for ways to increase system capacity without reducing communication quality beyond consumer tolerance thresholds. One technique to achieve these objectives involved changing from analog modulation based systems to digital modulation based systems.

[0004] In wireless digital communication systems, industry standards define most of the system parameters, including, for example, modulation type, burst format, communication and protocol. For example, the European Telecommunication Standard Institute (ETSI) established the Global System for Mobile Communications (GSM) standard that uses time division multiple access (TDMA) to transmit control, voice and data information over radio frequency (RF) physical channels or links and a Gaussian Minimum Shift Keying (GMSK) modulation scheme at a symbol rate of 271 kilosymbols per second (ksps). In the United States, the Telecommunication Industry Association (TIA) has published a number of Interim Standards, such as IS-54 and IS-136, that define various versions of Digital Advanced Mobile Phone Service (D-AMPS), a TDMA system that uses a Differential Quadrature Phase Shift Keying (DQPSK) modulation scheme for communicating data over RF links.

[0005] TDMA systems subdivide the allocated frequency into one or more RF channels. Each of the RF channels is further divided into a number of time frames. Each time frame is then divided into a number of timeslots, (e.g., three timeslots), wherein each timeslot corresponds to a physical channel. Logical channels are then formed from one or several physical channels.. In these systems the mobile stations communicate with one or more base stations by transmitting and receiving bursts of digital information over uplink and downlink RF channels.

[0006] Digital communication systems employ various techniques to handle erroneously received information. One such technique is FEC. In general, FEC involves transmitting additional bits that are used at the receiving end to verify the accuracy of the transmission, and if necessary, correct any errors. FEC techniques involve con-

volutional or block coding of the data prior to modulation, wherein it is common to refer to convolutional codes by a code rates (e.g., $\frac{1}{2}$ and $\frac{1}{3}$), wherein a lower code rates involves a greater number of code bits. Therefore, a lower code rate typically provides greater error protection. However, it also results in a lower user bit rate.

[0007] The technique used to select a code rate is called Link Adaptation (LA). LA works in conjunction with FEC by monitoring the quality of the channel or link and adjusting the code rate accordingly. For example, if the quality of the link is low, the code rate will be lowered. Alternatively, if the quality of the link is high, the code rate may be raised in order to provide a higher user bit rate.

[0008] Another common technique for handling erroneously received information is known as ARQ. In general, ARQ involves analyzing a received block of data for errors at the receiver and requesting that the sender retransmit the block of data if errors are detected. When processed by a receiver (e.g., a receiver in a mobile radio telephone), each block can, after demodulation, be evaluated for errors using a block check sequence and well known cyclic redundancy check techniques. If there are errors, then a request is sent back to the transmitting entity (e.g., a base station in a radiocommunication system) denoting the block to be resent using predefined ARQ protocols.

[0009] As one skilled in the art will appreciate, FEC techniques (e.g., FEC techniques including LA) may be combined with ARQ techniques. Such combined techniques are commonly referred to as hybrid ARQ techniques. Hybrid ARQ techniques permit correction of some received errors using FEC coding at the receiver, while correction of other errors may require retransmission.

[0010] FIG. 1 illustrates an exemplary hybrid ARQ scheme, known as Type I Hybrid ARQ. Type I Hybrid ARQ is used in conjunction with General Packet Radio Service (GPRS), wherein four FEC Modulation and Coding Schemes (MCS), CS-1 through CS-4 are employed with coding rates of $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, and 1, respectively. After one of the four FEC MCS is selected (using LA) for a current Logical Link Control (LLC) frame 110, segmentation of this frame to Logical Link Control (LLC) blocks, corresponding to the selected coding scheme, is performed. The LLC blocks include a payload of information 111, a frame header (H1) and a frame check sequence (FCS). The LLC blocks are coded with the selected rate forming a coded block 112. In order to reduce the number of bits in the coded block, bits can be removed using a known puncturing pattern to form the punctured coded block that will be used as the radio link control (RLC) block 113. If an RLC block is found to be erroneous at the receiver (i.e., it has errors which cannot be corrected) and needs to be retransmitted, the originally selected FEC coding (and puncturing) scheme is used for retransmission (i.e., this system employs fixed redundancy for retransmission purposes).

[0011] Another exemplary hybrid ARQ scheme, known as Incremental Redundancy (IR) or Type II hybrid ARQ, provides for additional redundant bits to be transmitted if the originally transmitted block cannot be decoded. This scheme is conceptually illustrated in FIG. 2. Therein, multiple decoding attempts are made by the receiver. First the receiver attempts to decode the originally received data block. If the receiver is unable to decode the originally received data block, the receiver sends a retransmission request to the sender. The receiver then receives additional redundant block R1, which it uses in conjunction with the originally transmitted data block to attempt decoding. The probability of decoding is increased due to the diversity of the two transmitted blocks. The Type II Hybrid ARQ retransmission (R1, R2) is optimized to be decoded in combination with previous transmissions and may or may not be separately decodable. If the receiver still cannot decode the data block, the receiver obtains another block of redundant information R2, which it uses in conjunction with the originally received data block and the block of redundant bits R1 to attempt decoding for a third time. This process can be repeated until successful decoding is achieved.

[0012] For a further discussion of Type II Hybrid ARQ, reference is made to "Complementary Punctured Convolutional (CPC) Codes and Their Applications," by S. Kallel in IEEE Transactions on Communications, volume 23, number 6, published June 1995.

[0013] Presently, using the above techniques, if a receiver using Type I Hybrid ARQ attempts to communicate with a transmitter using Type II Hybrid ARQ, assuming the coding scheme of the first transmitted block was known to the receiver, the receiver would not be able to decode any retransmission. In addition, even if the coding scheme for the retransmission was communicated to the Type I Hybrid ARQ receiver, the quality of service would be greatly diminished since the Type I Hybrid ARQ receiver will discard previous transmissions and the retransmissions are not optimized to be separately decodable.

[0014] Therefore, it is desirable for a transmitter to operate using a scheme that will allow receivers using either Type I Hybrid ARQ or receivers using Type II Hybrid ARQ to successfully receive and decode blocks from a common transmitter without the need for the transmitter to know which scheme is being employed by the receivers.

[0015] The prior art further includes Sandberg et al., Retransmission Schemes for Meteor-Burst Communications, Ninth Annual International Phoenix Conference on Computers and Communications, 1990, Conference Proceedings, pages 246-253, which discloses various hybrid ARQ retransmissions schemes for meteor-burst communications, including the use of a variable rate coding scheme in which the code rate is decreased as the meteor trail decays.

SUMMARY OF THE INVENTION

[0016] The present invention describes a transmitter that operates using a scheme that allows receivers using either Type I Hybrid ARQ or receivers using Type II Hybrid ARQ to successfully receive and decode blocks from a common transmitter without the need for the transmitter be informed of which scheme is being employed by the receivers.

[0017] The invention is defined in the independent claims. Particular embodiments are defined in the dependent claims.

[0018] According to a first aspect, the system is for communicating blocks of information to and from a transmitter and a receiver. The system comprises a transmitter that operates in an ARQ transmission mode and a plurality of receivers including a first receiver that operates in a first reception mode and a second receiver that operates in a second reception mode. The first receiver and the second receiver communicate with the transmitter while the transmitter operates in the ARQ transmission mode.

[0019] According to a further aspect, the communication device operates in an ARQ mode. The communication device comprises a memory that stores a plurality of coding schemes in a predetermined order. The communication device also includes a receiver that receives a block and one or more retransmitted blocks. The receiver individually processes each of the one or more retransmitted blocks using a different coding scheme corresponding to the predetermined order of the coding schemes stored in the memory. In addition, the block and each of the one or more retransmitted blocks are coded using the plurality of coding schemes and have a substantially equal probability of being independently decoded by the communication device.

[0020] According to a further aspect, the method is for transmitting and receiving blocks in a communication system. The method comprises transmitting the blocks in an ARQ transmission mode; receiving the blocks, at a first receiver, operating in a first reception mode; and receiving the blocks, at a second receiver, operating in a second reception mode.

[0021] According to a further aspect, the method is for receiving a block from a transmitter. The method comprises storing a plurality of coding schemes in a predetermined order; receiving, at a receiver, the block and one or more retransmitted blocks from the transmitter; and individually processing, at the receiver, each of the one or more retransmitted blocks using a different coding scheme corresponding to the predetermined order of the plurality of coding schemes. Each block and each of the one or more retransmitted blocks are coded using the plurality of coding schemes and have a substantially equal probability of being independently decoded by the receiver.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] These and other features, aspects, and advantages of the present invention will be understood by reading this description in conjunction with the drawings in which:

FIG. 1 illustrates an exemplary FEC scheme;
 FIG. 2 illustrates an exemplary hybrid ARQ scheme;
 FIG. 3 is a flow chart of a process performed by an exemplary transmitter of the present invention;
 FIG. 4 illustrates an exemplary hybrid ARQ scheme according to the present invention;
 FIGS. 5A & 5B are flow charts processes performed by exemplary receivers of the present invention;
 FIGS. 6A & 6B illustrate the exemplary MCSs for EGPRS; and
 FIGS. 7A & 7B illustrate exemplary coding and puncturing schemes of the present invention.

DETAILED DESCRIPTION

[0023] The present invention utilizes a new technique in which the transmitter does not need to be informed of the actual mode (e.g., Type I or Type II Hybrid ARQ) used by the receiver.

[0024] The following exemplary embodiments are provided in the context of TDMA radiocommunication systems. However, those skilled in the art will appreciate that TDMA is merely used for the purposes of illustration and that the present invention is readily applicable to other types of access methodologies including frequency division multiple access (FDMA), code division multiple access (CDMA) and hybrids thereof.

[0025] Moreover, operation in accordance with the GSM system is described in European Telecommunication Standard Institute (ETSI) documents ETS 300 573, ETS 300 574, and ETS 300 578. Therefore, the operations of the GSM system in conjunction with the present invention is only described herein to the extent necessary for understanding the present invention. Although, the present invention is described in terms of exemplary embodiments in an enhanced GPRS system, those skilled in the art will appreciate that the present invention could be used in a wide variety of other digital communication systems, such as those based on wideband CDMA or wireless Asynchronous Transfer Mode (ATM).

[0026] FIG. 3 illustrates a technique for transmitting blocks to a receiver in accordance with a first embodiment of the present invention, wherein blocks are transmitted and retransmitted to a receiver using different coding schemes. A coding rate from a coding scheme is selected in step 320 (e.g., $[1, 1/2, \dots, 1/n]$, $[1, 2/3, \dots, 2/n]$, or $[1, 3/4, \dots, 3/n]$). For purposes of illustration, the first code rate sequence (i.e., $(1, 1/2, \dots, 1/n)$) is used with a selective repeat ARQ scheme in the following discussion. A coded block using a first coding scheme P_1 (e.g., a convolution and/or puncturing scheme) is transmitted to a

receiver in step 322. In step 324, the transmitter awaits an acknowledgment signal (ACK). If no ACK is received or if a non-acknowledgment signal (NACK) is received, then the same block is transmitted in step 326 using a second coding scheme. If in step 328, no ACK is received or if a non-acknowledgment signal (NACK) is received, then the same block is transmitted in step 330 using a third coding scheme. This process can be repeated for n number of coding schemes P_n at which point the process returns to step 322 with coding scheme P_1 .

[0027] The second (and subsequent) coding schemes are optimized to have substantially the same probability of decoding as the first coding scheme. Since, for example, a Type I Hybrid ARQ receiver will decode successive blocks separately and a Type II Hybrid ARQ receiver will decode successive blocks jointly, by using coding schemes that have diversity as well as have substantially the same probability of decoding, both Type I and Type II Hybrid ARQ receivers will be able to decode the transmitted blocks without significantly reducing the quality of service for the transmission.

[0028] In order to optimize the coding schemes to have substantially the same probability of decoding, the different codes need to have a high number of distances between corresponding trellis paths. Each trellis path, for example, corresponds to a polynomial of a convolutional code that is punctured using a particular puncturing pattern. In order to increase the probability of decoding a particular coding scheme, the minimum distance for all of the trellis paths should be as high as possible (e.g., for a code rate of $1/3$ and a constraint length of 7, a high value for the minimum distance is 14-15). In addition, the actual occurrence of the minimum distance for all trellis paths should be kept as low as possible (e.g., 1). Once a coding scheme is selected (e.g., P_1) using the above method, then the next best coding scheme is selected and so forth (e.g., P_2, P_3, P_n). The next best coding scheme is determined by using the same procedure as stated above with respect to the best coding scheme.

[0029] Once multiple coding schemes are determined which have substantially the same probability of decoding, the coding schemes can be optimized for joint decoding by selecting coding schemes that, in combination, have a high minimum distance. That is, for example, the differences in trellis paths using the first coding scheme can be examined in combination with the differences in trellis paths using additional coding schemes in order to measure the distance in trellis paths for all of the coding schemes.

[0030] An exemplary technique of generating three puncturing patterns (P_i, P_j, P_k) for use with the present invention is described below. A plurality of puncturing patterns P_i , where $i = 1$ to N are created that correspond to a desired code rate, (e.g., the puncturing patterns reduce the number of total output bits per convolutional code, thereby increasing the code rate). The minimum distance, $d_{\min-i}$ for each trellis path of P_i is calculated. A first threshold value, $d_{\text{threshold}_1}$, is determined that rep-

resents an acceptable minimum distance threshold for a single puncturing pattern for a particular code rate of a communication system. A second threshold value, $d_{\text{threshold_2}}$, is determined that represents an acceptable minimum distance threshold for the joint decoding of two puncturing patterns for a particular code rate of a communication system. A third threshold value, $d_{\text{threshold_3}}$, is determined that represents an acceptable minimum distance threshold for the joint decoding of three puncturing patterns for a particular code rate of a communication system. Each successive threshold value will be less than or equal to the previous threshold value. The number of threshold values calculated corresponds to the number of puncturing patterns that will be used by the communication system of the present invention.

[0031] Three puncturing patterns (P_i , P_j , P_k) are selected such that: the minimum distance of P_i ($d_{\text{min_i}}$), the minimum distance of P_j ($d_{\text{min_j}}$), and the minimum distance of P_k ($d_{\text{min_k}}$) are all greater than $d_{\text{threshold_1}}$; the minimum distance of P_i and P_j ($d_{\text{min_ij}}$), the minimum distance of P_j and P_k ($d_{\text{min_jk}}$), and the minimum distance of P_i and P_k ($d_{\text{min_ik}}$) are all greater than $d_{\text{threshold_2}}$; and the minimum distance of P_i , P_j , and P_k ($d_{\text{min_ijk}}$) is greater than $d_{\text{threshold_3}}$. Puncturing patterns which satisfy the above criteria are therefore optimized to be decodable both individually (e.g., in a Type I Hybrid ARQ system) and in combination (e.g., in a Type II Hybrid ARQ system).

[0032] FIG. 4 illustrates a schematic view of the exemplary technique illustrated in FIG. 3. The LLC frames 440 are segmented into blocks of different sizes depending on the MCS to be used. In an alternative embodiment of the present invention, a fixed code rate is used and no coding or modulation adaptation is performed.

[0033] A FCS and a header (H1) are added to each of the segmented blocks 441. The entire block is convolutionally encoded with a rate $1/n$ code to produce coded block 442. To achieve different code rates, some bits are then punctured from the coded block 442. In an alternative embodiment of the present invention, the header (or a portion of the header) is less punctured, or not punctured at all, in order to increase the robustness of the header regardless of the MCS used. In addition, the header (or a portion of the header) can also be coded separately from the data using, for example, another convolutional code (possibly punctured) or a block code. Furthermore, the header can have its own FCS in order to avoid false detection of the header. Successful decoding of the header with high certainty, allows for the reliable combining and decoding of blocks. This technique can be useful with Type II Hybrid ARQ receivers by making it easier for the receiver to determine the identity of the received block (since the identity is contained in the header) so that it can be combined with the retransmitted block in the event that only the header could be decoded.

[0034] For each MCS, a number of puncturing patterns exist (e.g., $P_1 \dots P_n$). If the initial code rate is less than 1, $P_1 \dots P_n$ are not disjunctive. In addition, if the initial code

is $1/n$, $P_1 \dots P_n$ are equal (e.g., no bits are punctured) and the IR operation of Type II Hybrid ARQ reduces to that of a repetition code. In both Type I and Type II Hybrid ARQ mode, the first block, punctured with P_1 , is transmitted to the receiver. If decoding is unsuccessful, the second block, punctured with P_2 is sent, and so forth. The difference between the Type I and Type II Hybrid ARQ operation, is that in the Type I mode, the block using P_1 is discarded if decoding fails, and the next attempt is based solely on the block using P_2 .

[0035] In the Type II Hybrid ARQ mode, soft information about the block using P_1 is stored and joint decoding, e.g., by soft combining information from P_1 and P_2 , is performed. Thus, the transmitter does not need to know whether the receiver is in a Type I or Type II Hybrid ARQ mode, since the receiver will either treat each block separately (e.g., in Type I mode) or joint decode the successive blocks (e.g., in IR mode).

[0036] FIG. 5A illustrates a technique for receiving and decoding blocks using a receiver operating in a Type I Hybrid ARQ mode according to the present invention. The first block is received in step 540. In step 542, the receiver determines if it was able to decode the block. If the receiver was able to decode the block, using a first coding scheme, an ACK is sent in step 544 and the receiver waits for the next block of an LLC frame (or a block from a new LLC frame). If the receiver is unable to decode the block, a NACK is sent in step 546 and the first block is discarded. A second block is received in step 548 and in step 550 if the transmitter can decode the block using a second coding scheme, then an ACK is sent in step 544. If the receiver is unable to decode the block, a NACK is sent to the transmitter and the second block is discarded in step 552. A third block is received in step 554 and in step 556 if the transmitter can decode the block using a third coding scheme, then an ACK is sent in step 544. If the receiver is unable to decode the block, a NACK is sent to the transmitter and the third block is discarded in step 558. This process can be repeated for n number of coding schemes at which point the process returns to step 540 using the first coding scheme. The coding schemes (and their relative order) can be stored in the transmitter or can be sent to the transmitter in a separate control signal using, for example, side band signaling.

[0037] FIG. 5B illustrates a technique for receiving and decoding blocks using a receiver operating in a Type II Hybrid ARQ mode according to the present invention. The first block coded using a first coding scheme is received in step 560. In step 562, the receiver determines if it was able to decode the block. If the receiver was able to decode the block, using a first coding scheme, an ACK is sent in step 564 and the receiver waits for the next block of an LLC frame (or a block from a new LLC frame). If the receiver is unable to decode the block, a NACK is sent in step 566. A second block coded using a second coding scheme is received in step 568 and in step 570 if the transmitter can decode the block by joint decoding the first and second blocks, then an ACK is sent in step

564. If the receiver is unable to joint decode the blocks, a NACK is sent to the transmitter in step 572. A third block coded using a third coding scheme is received in step 574 and in step 576 if the transmitter can decode the block by joint decoding the first, second, and third blocks, then an ACK is sent in step 544. If the receiver is unable to decode the block, a NACK is sent to the transmitter in step 578. This process can be repeated for n number of coding schemes at which point the process returns to step 560 using the first coding scheme. The coding schemes (and their relative order) can be stored in the transmitter or can be sent to the transmitter in a separate control signal using, for example, in-band or side-band signaling.

[0038] The present invention will now be described with reference to providing Link Quality Control (LQC) in Enhanced GPRS. The initial code rate can be selected based on link quality measurements performed by the transmitter and/or receiver. Type II Hybrid ARQ operation is enabled by puncturing a different set of bits for retransmissions. Different switching points for selecting the initial code rate can be used in the LA and IR modes. In standard GPRS, selective ARQ is used and acknowledgments (ACKs) and non-acknowledgments (NACKs) are signaled using bitmaps. In order to protect the header, the header is interleaved over four GSM bursts. Using the 8PSK uncoded mode, the present invention allows for the transmission of two RLC blocks per 20 milliseconds (ms). This allows better performance if using frequency hopping techniques while limiting the ACK/NACK bitmap size and allowing robust header coding.

[0039] Exemplary MCSs for EGPRS are illustrated in FIGS. 6A and 6B. The MCSs are divided into different families (e.g., A, B and C). Each family has a different basic unit of payload (e.g., 37, 28 and 22 octets, respectively). Different code rates within a family are achieved by transmitting a different number of payload units within a 20 ms block. For example, for families A and B, one, two, or four payload units are transmitted. For family C, only one or two units are transmitted.

[0040] In cases where four payload units are transmitted (MCS-7 and MCS-8), the payload units are split into two RLC blocks using separate sequence numbers and CRCs. The MCS-8 blocks are interleaved over only two bursts because it yields a better performance than interleaving over four bursts for high code rates, especially when the burst quality is uncorrelated when, for example, using a frequency hopping technique.

[0041] For an initial transmission, any MCS can be selected based on the current link quality. For retransmissions in the LA mode that require increased robustness, two alternative embodiments exist. In the first alternative embodiment, if MCS-7 or MCS-8 was initially used, the block can be retransmitted at half the original code rate using one MCS-5 or MCS-6 block respectively. In the second alternative embodiment, if MCS-4, MCS-5, or MCS-6 was initially used, the block can be transmitted using two MCS-1, MCS-2, or MCS-3 blocks respectively.

In the second alternative embodiment, two bits in the header will indicate that the RLC block has been split and the relative order of the parts of the RLC block. For example, a block that was initially transmitted using uncoded 8PSK can be retransmitted using GMSK based MCS-3.

[0042] FIGS. 7A and 7B illustrate exemplary coding and puncturing schemes of the present invention using MCS-5 and MCS-8, respectively. The data block includes a Uplink State Flag (USF), a RLC Header, a Tail Bits (TB) field, a Final Block Indicator (FBI) field, an Extension bit (E) field, a data payload field, and a Block Check Sequence (BCS).

[0043] In an exemplary embodiment of the present invention, each 8PSK block includes 1392 bits and each GMSK block includes 464 bits. The USF is 36 bits for 8PSK and 12 bits for GMSK. There are four stealing bits (SB) for 8PSK indicating two different header types and eight stealing bits for GMSK indicating only one header type. The RLC headers are coded as discussed above and there are two bits used for the FBI and E fields. A 12 bit CRC and 6 bit tail are added to the payload for data protection.

[0044] In the description above, the blocks are derived with the same convolutional code, but with different puncturing patterns. Of course, one skilled in the art will recognize that the blocks can be obtained by using different convolutional codes or block codes, or a combination of both. For example, the blocks can be obtained with different, relatively low-complex convolutional codes and turbo decoding can be applied in the receiver.

[0045] Although the invention has been described in detail with reference only to a few exemplary embodiments, those skilled in the art will appreciate that various modifications can be made without departing from the invention. For example, the code rate before puncturing is not limited to any particular rate, but can be any value which is suitable for the use and environment of the present invention. Furthermore, a coded block does not have to be of a fixed size (i.e., a block may vary in size from block to block). In addition, the coded block size could be, for example, a function of the initial code rate selected. Alternatively, a different coded block size could be used, for example, for each successive block.

Claims

1. A communication device that is configured to operate in an ARQ mode, comprising:

a memory that is configured to store a plurality of coding schemes in a predetermined order; and

a receiver that is configured to receive a block and one or more retransmitted blocks, wherein said receiver is configured to individually process each of said one or more retrans-

mitted blocks using a different coding scheme corresponding to the predetermined order of said coding schemes stored in said memory, and

characterized in that

said block and each of said one or more retransmitted blocks are coded using said plurality of coding schemes and are optimized to be decodable both individually, for an ARQ mode reception without using incremental redundancy, and in combination, for an ARQ mode reception using incremental redundancy.

2. The communication device of claim 1, wherein said ARQ mode is a Type I Hybrid ARQ mode.

3. The communication device of claim 1, wherein each of said coding schemes uses a different puncturing pattern.

4. The communication device of claim 1, wherein each of said coding schemes uses a convolutional code.

5. A communication device that is configured to operate in an ARQ mode, comprising:

a memory that is configured to store a plurality of coding schemes in a predetermined order; and

a transmitter that is configured to transmit a block and one or more retransmitted blocks, wherein said transmitter is configured to individually process each of said one or more blocks to be retransmitted using a different coding scheme corresponding to the predetermined order of said coding schemes stored in said memory, and

characterized in that

said block and each of said one or more retransmitted blocks are coded using said plurality of coding schemes and are optimized to be decodable both individually, for an ARQ mode reception without using incremental redundancy, and in combination, for an ARQ mode reception using incremental redundancy.

6. The communication device of claim 5, wherein said ARQ mode is a Type I Hybrid ARQ mode.

7. The communication device of claim 5, wherein each of said coding schemes uses a different puncturing pattern.

8. The communication device of claim 5, wherein each of said coding schemes uses a convolutional code.

9. A communication system comprising:

a transmitter communication device of claim 5, that is configured to operate in an ARQ transmission mode;

characterized by further comprising

a plurality of receiver communication devices including a first receiver communication device of claim 1, that is configured to operate in a first reception mode, and a second receiver communication device of claim 1, that is configured to operate in a second reception mode;

wherein said first receiver communication device and said second receiver communication device are configured to communicate with said transmitter communication device while said transmitter communication device operates in said ARQ transmission mode, and

wherein said first reception mode is an ARQ mode without using incremental redundancy and said second reception mode is an ARQ mode using incremental redundancy, wherein said ARQ transmission mode uses incremental redundancy, wherein retransmitted blocks are coded differently than an original transmitted block, by using successive coding schemes optimized to be decodable both individually and in combination.

10. The communication system of claim 9, wherein said ARQ transmission mode uses incremental redundancy, wherein retransmitted blocks are coded differently than an original transmitted block, and wherein each retransmitted block may be independently decoded.

11. The communication system of claim 9, wherein said first reception mode is a Type I Hybrid ARQ mode and said second reception mode is a Type II Hybrid ARQ mode.

12. The communication system of claim 9, wherein said ARQ transmission mode is a Type II Hybrid ARQ mode adapted to retransmit blocks that are coded differently than an originally transmitted block, and wherein each retransmitted block may be independently decoded.

13. The communication system of claim 10, wherein said blocks are coded differently by changing a puncturing pattern for each retransmitted block.

14. The communication system of claim 10, wherein said blocks are coded differently by changing a convolutional code for each retransmitted block.

15. The communication system of claim 12, wherein said blocks are coded differently by changing a puncturing pattern for each retransmitted block.

16. The communication system of claim 12, wherein said blocks are coded differently by changing a convolutional code for each retransmitted block.

17. The communication system of claim 9, wherein said ARQ transmission mode includes link adaptation.

18. The communication system of claim 15, wherein said ARQ transmission mode includes link adaptation.

19. The communication system of claim 13, wherein a code rate is varied by changing said puncturing pattern.

20. The communication system of claim 10, wherein said ARQ transmission mode includes link adaptation and wherein different code rates for link adaptation as well as different coded versions for incremental redundancy are created by puncturing the same convolutional code.

21. A method of receiving a block from a transmitter comprising:

storing a plurality of coding schemes in a predetermined order;

receiving, at a receiver, said block and one or more retransmitted blocks from said transmitter; and

individually processing, at the receiver, each of said one or more retransmitted blocks using a different coding scheme corresponding to the predetermined order of said plurality of coding schemes,

characterized in that

said block and each of said one or more retransmitted blocks are coded using said plurality of coding schemes and are optimized to be decodable both individually, for an ARQ mode reception without using incremental redundancy, and in combination, for an ARQ mode reception using incremental redundancy.

22. The method of claim 21, wherein said ARQ mode is a Type I Hybrid ARQ mode.

23. The method of claim 21, wherein each of said coding schemes uses a different puncturing pattern.

24. The method of claim 21, wherein each of said coding schemes uses a convolutional code.

25. A method of transmitting a block to a receiver comprising:

storing a plurality of coding schemes in a predetermined order;

individually processing, at a transmitter, each of

one or more blocks to be retransmitted using a different coding scheme corresponding to the predetermined order of said plurality of coding schemes,

transmitting, at the transmitter, said block and one or more retransmitted blocks to said receiver; and

characterized in that

said block and each of said one or more retransmitted blocks are coded using said plurality of coding schemes and are optimized to be decodable both individually, for an ARQ mode reception without using incremental redundancy, and in combination, for an ARQ mode reception using incremental redundancy.

26. The method of claim 25, wherein said ARQ mode is a Type I Hybrid ARQ mode.

27. The method of claim 25, wherein each of said coding schemes uses a different puncturing pattern.

28. The method of claim 25, wherein each of said coding schemes uses a convolutional code.

29. A method of transmitting and receiving blocks in a communication system comprising:

transmitting, in accordance with the method of claim 25, said blocks in an ARQ transmission mode;

characterized by further comprising:

receiving, in accordance with the method of claim 21, said blocks, at a first receiver, operating in a first reception mode; and receiving, in accordance with the method of claim 21, said blocks, at a second receiver, operating in a second reception mode, wherein said first reception mode is an ARQ mode without using incremental redundancy and said second reception mode is an ARQ mode using incremental redundancy, wherein said ARQ transmission mode uses incremental redundancy, wherein retransmitted blocks are coded differently than an original transmitted block, by using successive coding schemes optimized to be decodable both individually and in combination.

30. The method of claim 29, wherein said ARQ transmission mode uses incremental redundancy, wherein retransmitted blocks are coded differently than an original transmitted block, and wherein each retransmitted block may be independently decoded.

31. The method of claim 29, wherein said first reception mode is a Type I Hybrid ARQ mode and said second

reception mode is a Type II Hybrid ARQ mode.

32. The method of claim 29, wherein said ARQ transmission mode is a Type II Hybrid ARQ mode adapted to retransmit blocks that are coded differently than an originally transmitted block, and wherein each retransmitted block may be independently decoded. 5
33. The method of claim 30, wherein said blocks are coded differently by changing a puncturing pattern for each retransmitted block. 10
34. The method of claim 30, wherein said blocks are coded differently by changing a convolutional code for each retransmitted block. 15
35. The method of claim 32, wherein said blocks are coded differently by changing a puncturing pattern for each retransmitted block. 20
36. The method of claim 32, wherein said blocks are coded differently by changing a convolutional code for each retransmitted block.
37. The method of claim 29, wherein said ARQ transmission mode includes link adaptation. 25
38. The method of claim 35, wherein said ARQ transmission mode includes link adaptation. 30
39. The method of claim 33, wherein a code rate is varied by changing said puncturing pattern.
40. The method of claim 30, wherein said ARQ transmission mode includes link adaptation and wherein different code rates for link adaptation as well as different coded versions for incremental redundancy are created by puncturing the same convolutional code. 35 40

Patentansprüche

1. Kommunikationsvorrichtung, die konfiguriert ist, in einem ARQ-Modus betrieben zu werden, umfassend: 45
 - einen Speicher, der konfiguriert ist, eine Vielzahl an Codierschemata in einer vorbestimmten Reihenfolge zu speichern; und 50
 - einen Empfänger, der konfiguriert ist, einen Block und einen oder mehr erneut gesendete Blöcke zu empfangen,
 - wobei der Empfänger konfiguriert ist, jeden aus den einen oder mehr erneut gesendeten Blöcken einzeln zu verarbeiten, unter Nutzung eines anderen Codierschemas entsprechend der vorbestimmten Reihenfolge der Codierschemata, 55

die in dem Speicher gespeichert sind, und

dadurch gekennzeichnet, dass

der Block und jeder aus den einen oder mehr erneut gesendeten Blöcken unter Nutzung der Vielzahl von Codierschemata codiert sind und optimiert sind, um sowohl einzeln decodierbar zu sein, für einen ARQ-Modus-Empfang ohne Nutzung von inkrementeller Redundanz, wie auch in Kombination, für einen ARQ-Modus-Empfang unter Nutzung von inkrementeller Redundanz.

2. Kommunikationsvorrichtung nach Anspruch 1, wobei der ARQ-Modus ein Typ-I-Hybrid-ARQ-Modus ist.
3. Kommunikationsvorrichtung nach Anspruch 1, wobei jedes aus den Codierschemata ein anderes Punktierrmuster (engl.: puncturing pattern) nutzt.
4. Kommunikationsvorrichtung nach Anspruch 1, wobei jedes aus den Codierschemata einen Faltungscode (engl.: convolutional code) nutzt.
5. Kommunikationsvorrichtung, die konfiguriert ist, in einem ARQ-Modus betrieben zu werden, umfassend:

einen Speicher, der konfiguriert ist, eine Vielzahl an Codierschemata in einer vorbestimmten Reihenfolge zu speichern,

einen Sender, der konfiguriert ist, einen Block und einen oder mehr erneut gesendete Blöcke zu senden,

wobei der Sender konfiguriert ist, jeden aus den einen oder mehr Blöcken, die erneut gesendet werden sollen, einzeln zu verarbeiten, unter Nutzung eines anderen Codierschemas entsprechend der vorbestimmten Reihenfolge der Codierschemata, die in dem Speicher gespeichert sind, und

dadurch gekennzeichnet, dass

der Block und jeder aus den einen oder mehr erneut gesendeten Blöcke unter Nutzung der Vielzahl von Codierschemata codiert sind und optimiert sind, um sowohl einzeln decodierbar zu sein, für einen ARQ-Modus-Empfang ohne Nutzung von inkrementeller Redundanz, wie auch in Kombination, für einen ARQ-Modus-Empfang unter Nutzung von inkrementeller Redundanz.

6. Kommunikationsvorrichtung nach Anspruch 5, wobei der ARQ-Modus ein Typ-I-Hybrid-ARQ-Modus ist.

7. Kommunikationsvorrichtung nach Anspruch 5, wobei jedes aus den Codierschemata ein anderes Punktmuster nutzt.
8. Kommunikationsvorrichtung nach Anspruch 5, wobei jedes aus den Codierschemata einen Faltungscode nutzt.
9. Kommunikationssystem, umfassend:
- eine Sender-Kommunikationsvorrichtung nach Anspruch 5, die konfiguriert ist, in einem ARQ-Sendemodus betrieben zu werden;
dadurch gekennzeichnet, dass es ferner umfasst:
- eine Vielzahl von Empfänger-Kommunikationsvorrichtungen, die eine erste Empfänger-Kommunikationsvorrichtung nach Anspruch 1 umfasst, die konfiguriert ist, in einem ersten Empfangsmodus betrieben zu werden, und eine zweite Empfänger-Kommunikationsvorrichtung nach Anspruch 1, die konfiguriert ist, in einem zweiten Empfangsmodus betrieben zu werden;
wobei die erste Empfänger-Kommunikationsvorrichtung und die zweite Empfänger-Kommunikationsvorrichtung konfiguriert sind, mit der Sender-Kommunikationsvorrichtung zu kommunizieren, während die Sender-Kommunikationsvorrichtung in dem ARQ-Sendemodus betrieben wird, und
wobei der erste Empfangsmodus ein ARQ-Modus ist, ohne Nutzung von inkrementeller Redundanz und der zweite Empfangsmodus ein ARQ-Modus ist unter Nutzung von inkrementeller Redundanz, wobei der ARQ-Sendemodus inkrementelle Redundanz nutzt, wobei erneut gesendete Blöcke anders codiert sind als ein ursprünglich gesendeter Block, unter Nutzung von sukzessiven Codierschemata, die optimiert sind, sowohl einzeln wie auch in Kombination decodierbar zu sein.
10. Kommunikationssystem nach Anspruch 9, wobei der ARQ-Sendemodus inkrementelle Redundanz nutzt, wobei erneut gesendete Blöcke anders codiert sind als ein ursprünglich gesendeter Block, und wobei jeder erneut gesendete Block unabhängig decodiert werden kann.
11. Kommunikationssystem nach Anspruch 9, wobei der erste Empfangsmodus ein Typ-I-Hybrid-ARQ-Modus ist und der zweite Empfangsmodus ein Typ-II-Hybrid-ARQ-Modus ist.
12. Kommunikationssystem nach Anspruch 9, wobei der ARQ-Sendemodus ein Typ-II-Hybrid-ARQ-Modus ist, der angepasst ist, Blöcke erneut zu senden, die anders codiert sind, als ein ursprünglich gesendeter Block, und wobei jeder erneut gesendete Block unabhängig decodiert werden kann.
13. Kommunikationssystem nach Anspruch 10, wobei die Blöcke anders codiert werden durch ein Ändern eines Punktmusters für jeden erneut gesendeten Block.
14. Kommunikationssystem nach Anspruch 10, wobei die Blöcke anders codiert werden durch ein Ändern eines Faltungscode für jeden erneut gesendeten Block.
15. Kommunikationssystem nach Anspruch 12, wobei die Blöcke anders codiert werden durch ein Ändern eines Punktmusters für jeden erneut gesendeten Block.
16. Kommunikationssystem nach Anspruch 12, wobei die Blöcke anders codiert werden durch ein Ändern eines Faltungscode für jeden erneut gesendeten Block.
17. Kommunikationssystem nach Anspruch 9, wobei der ARQ-Sendemodus eine Verbindungsanpassung umfasst.
18. Kommunikationssystem nach Anspruch 15, wobei der ARQ-Sendemodus eine Verbindungsanpassung umfasst.
19. Kommunikationssystem nach Anspruch 13, wobei eine Coderate durch ein Ändern des Punktmusters variiert wird.
20. Kommunikationssystem nach Anspruch 10, wobei der ARQ-Sendemodus eine Verbindungsanpassung umfasst und wobei verschiedene Coderaten für eine Verbindungsanpassung und verschiedene codierte Versionen für inkrementelle Redundanz erzeugt werden durch Punktieren desselben Faltungscode.
21. Verfahren zum Empfangen eines Blocks von einem Sender, umfassend:
- ein Speichern einer Vielzahl von Codierschemata in einer vorbestimmten Reihenfolge;
ein Empfangen, an einem Empfänger, des Blocks und eines oder mehr erneut gesendeten Blöcke von dem Sender; und
ein einzelnes Verarbeiten, an dem Empfänger, von jedem der einen oder mehr erneut gesendeten Blöcke unter Nutzung eines anderen Co-

- dierschemas, entsprechend der vorbestimmten Reihenfolge der Vielzahl von Codierschemata, **dadurch gekennzeichnet, dass** der Block und jeder von den einen oder mehr erneut gesendeten Blöcken unter Nutzung der Vielzahl von Codierschemata codiert sind und optimiert sind, sowohl einzeln, für einen ARQ-Modus-Empfang ohne Nutzung von inkrementeller Redundanz, wie auch in Kombination, für einen ARQ-Modus-Empfang unter Nutzung von inkrementeller Redundanz decodierbar zu sein.
22. Verfahren nach Anspruch 21, wobei der ARQ-Modus ein Typ-I-Hybrid-ARQ-Modus ist.
23. Verfahren nach Anspruch 21, wobei jedes der Codierschemata ein anderes Punktiernmuster nutzt.
24. Verfahren nach Anspruch 21, wobei jedes der Codierschemata einen Faltungscode nutzt.
25. Verfahren zum Senden eines Blocks an einen Empfänger, umfassend:
- ein Speichern einer Vielzahl von Codierschemata in einer vorbestimmten Reihenfolge;
- ein einzelnes Verarbeiten, an dem Sender, von jedem der einen oder mehr Blöcke, die erneut gesendet werden sollen, unter Nutzung eines anderen Codierschemas, entsprechend der vorbestimmten Reihenfolge der Vielzahl von Codierschemata,
- ein Senden, an dem Sender, des Blocks und eines oder mehr erneut gesendeten Blöcke an den Empfänger; und
- dadurch gekennzeichnet, dass** jeder Block und jeder von den einen oder mehr erneut gesendeten Blöcken unter Nutzung der Vielzahl von Codierschemata codiert sind und optimiert sind, sowohl einzeln, für einen ARQ-Modus-Empfang ohne Nutzung von inkrementeller Redundanz, wie auch in Kombination, für einen ARQ-Modus-Empfang unter Nutzung von inkrementeller Redundanz decodierbar zu sein.
26. Verfahren nach Anspruch 25, wobei der ARQ-Modus ein Typ-I-Hybrid-ARQ-Modus ist.
27. Verfahren nach Anspruch 25, wobei jedes der Codierschemata ein anderes Punktiernmuster nutzt.
28. Verfahren nach Anspruch 25, wobei jedes der Codierschemata einen Faltungscode nutzt.
29. Verfahren zum Senden und Empfangen von Blöcken in einem Kommunikationssystem, umfassend:

ein Senden, gemäß dem Verfahren nach An-

spruch 25, der Blöcke in einem ARQ-Sendemodus;

dadurch gekennzeichnet, dass es ferner umfasst:

ein Empfangen, gemäß dem Verfahren nach Anspruch 21, der Blöcke, an einem ersten Empfänger, der in einem ersten Empfangsmodus betrieben wird; und

ein Empfangen, gemäß dem Verfahren nach Anspruch 21, der Blöcke, an einem zweiten Empfänger, der in einem zweiten Empfangsmodus betrieben wird, wobei der erste Empfangsmodus ein ARQ-Modus ist, ohne Nutzung von inkrementeller Redundanz und der zweite Empfangsmodus ein ARQ-Modus ist unter Nutzung von inkrementeller Redundanz, wobei der ARQ-Sendemodus inkrementelle Redundanz nutzt, wobei erneut gesendete Blöcke anders codiert werden als ein ursprünglich gesendeter Block, unter Nutzung von sukzessiven Codierschemata, die optimiert sind, sowohl einzeln wie auch in Kombination decodierbar zu sein.

30. Verfahren nach Anspruch 29, wobei der ARQ-Sendemodus inkrementelle Redundanz nutzt, wobei erneut gesendete Blöcke anders codiert sind als ein ursprünglich gesendeter Block, und wobei jeder erneut gesendeter Block unabhängig decodiert werden kann.
31. Verfahren nach Anspruch 29, wobei der erste Empfangsmodus ein Typ-I-Hybrid-ARQ-Modus ist und der zweite Empfangsmodus ein Typ-II-Hybrid-ARQ-Modus ist.
32. Verfahren nach Anspruch 29, wobei der ARQ-Sendemodus ein Typ-II-Hybrid-ARQ-Modus ist, der angepasst ist, Blöcke erneut zu senden, die anders codiert sind, als ein ursprünglich gesendeter Block, und wobei jeder erneut gesendete Block unabhängig decodiert werden kann.
33. Verfahren nach Anspruch 30, wobei die Blöcke anders codiert werden, durch ein Ändern eines Punktiernmusters für jeden erneut gesendeten Block.
34. Verfahren nach Anspruch 30, wobei die Blöcke anders codiert werden durch ein Ändern eines Faltungscode für jeden erneut gesendeten Block.
35. Verfahren nach Anspruch 32, wobei die Blöcke anders codiert werden durch ein Ändern eines Punktiernmusters für jeden erneut gesendeten Block.
36. Verfahren nach Anspruch 32, wobei die Blöcke an-

ders codiert werden, durch ein Ändern eines Faltungscodes für jeden erneut gesendeten Block.

37. Verfahren nach Anspruch 29, wobei der ARQ-Sendemodus eine Verbindungsanpassung umfasst. 5
38. Verfahren nach Anspruch 35, wobei der ARQ-Sendemodus eine Verbindungsanpassung umfasst.
39. Verfahren nach Anspruch 33, wobei eine Coderate durch ein Ändern des Punktiernusters variiert wird. 10
40. Verfahren nach Anspruch 30, wobei der ARQ-Sendemodus eine Verbindungsanpassung umfasst und wobei verschiedene Coderaten für eine Verbindungsanpassung und verschiedene codierte Versionen für inkrementelle Redundanz erzeugt werden durch Punktieren desselben Faltungscodes. 15

Revendications

1. Dispositif de communication qui est configuré pour fonctionner dans un mode de type demande de répétition automatique, dit mode ARQ, comprenant : 25
 - une mémoire qui est configurée pour stocker une pluralité de schémas de codage suivant un ordre prédéterminé ; et
 - un récepteur qui est configuré pour recevoir un bloc et un ou plusieurs blocs retransmis, dans lequel ledit récepteur est configuré pour traiter individuellement chacun desdits un ou plusieurs blocs retransmis en utilisant un schéma de codage différent correspondant à l'ordre prédéterminé desdits schémas de codage stockés dans ladite mémoire, et
 - caractérisé en ce que** ledit bloc et chacun desdits un ou plusieurs blocs retransmis sont codés en utilisant ladite pluralité de schémas de codage et sont optimisés pour être tous deux individuellement décodables, pour une réception en mode ARQ sans utilisation d'une redondance incrémentale, et de manière combinée, pour une réception en mode ARQ avec utilisation d'une redondance incrémentale. 40
2. Dispositif de communication de la revendication 1, dans lequel ledit mode ARQ est un mode ARQ hybride de type I. 50
3. Dispositif de communication de la revendication 1, dans lequel chacun desdits schémas de codage utilise un modèle de perforation différent. 55
4. Dispositif de communication de la revendication 1, dans lequel chacun desdits schémas de codage uti-

lise un code convolutionnel.

5. Dispositif de communication qui est configuré pour fonctionner en un mode ARQ, comprenant :
 - une mémoire qui est configurée pour stocker une pluralité de schémas de codage suivant un ordre prédéterminé ; et
 - un transmetteur qui est configuré pour transmettre un bloc et un ou plusieurs blocs retransmis, dans lequel ledit transmetteur est configuré pour traiter individuellement chacun desdits un ou plusieurs blocs à retransmettre en utilisant un schéma de codage différent correspondant à l'ordre prédéterminé desdits schémas de codage stockés dans ladite mémoire, et
 - caractérisé en ce que** ledit bloc et chacun desdits un ou plusieurs blocs retransmis sont codés en utilisant ladite pluralité de schémas de codage et sont optimisés pour être tous deux individuellement décodables, pour une réception en mode ARQ sans utilisation d'une redondance incrémentale, et de manière combinée, pour une réception en mode ARQ avec utilisation d'une redondance incrémentale.
6. Dispositif de communication de la revendication 5, dans lequel ledit mode ARQ est un mode ARQ hybride de type I.
7. Dispositif de communication de la revendication 5, dans lequel chacun desdits schémas de codage utilise un modèle de perforation différent.
8. Dispositif de communication de la revendication 5, dans lequel chacun desdits schémas de codage utilise un code convolutionnel.
9. Système de communication comprenant :
 - un dispositif de communication transmetteur de la revendication 5, qui est configuré pour fonctionner en un mode de transmission ARQ ;
 - caractérisé en ce qu'il** comprend en outre une pluralité de dispositifs de communication récepteur incluant un premier dispositif de communication récepteur de la revendication 1, qui est configuré pour fonctionner en un premier mode de réception, et un deuxième dispositif de communication récepteur de la revendication 1, qui est configuré pour fonctionner en un deuxième mode de réception ;
 - dans lequel ledit premier dispositif de communication récepteur et ledit deuxième dispositif de communication récepteur sont configurés pour communiquer avec ledit dispositif de communi-

- cation transmetteur lorsque ledit dispositif de communication transmetteur fonctionne dans ledit mode de transmission ARQ, et dans lequel ledit premier mode de réception est un mode ARQ sans utilisation d'une redondance incrémentale et ledit deuxième mode de réception est un mode ARQ avec utilisation d'une redondance incrémentale, dans lequel ledit mode de transmission ARQ utilise une redondance incrémentale, dans lequel des blocs retransmis sont codés différemment d'un bloc transmis original, en utilisant des schémas de codage successifs optimisés pour être tous deux individuellement décodables et de manière combinée.
10. Système de communication de la revendication 9, dans lequel ledit mode de transmission ARQ utilise une redondance incrémentale, dans lequel des blocs retransmis sont codés différemment d'un bloc transmis original, et dans lequel chaque bloc retransmis peut être décodé de manière indépendante.
11. Système de communication de la revendication 9, dans lequel ledit premier mode de réception est un mode ARQ hybride de type I et ledit deuxième mode de réception est un mode ARQ hybride de type II.
12. Système de communication de la revendication 9, dans lequel ledit mode de transmission ARQ est un mode ARQ hybride de type II adapté pour retransmettre des blocs qui sont codés différemment d'un bloc transmis original, et dans lequel chaque bloc retransmis peut être décodé de manière indépendante.
13. Système de communication de la revendication 10, dans lequel lesdits blocs sont codés différemment en changeant un modèle de perforation pour chaque bloc retransmis.
14. Système de communication de la revendication 10, dans lequel lesdits blocs sont codés différemment en changeant un code convolutionnel pour chaque bloc retransmis.
15. Système de communication de la revendication 12, dans lequel lesdits blocs sont codés différemment en changeant un modèle de perforation pour chaque bloc retransmis.
16. Système de communication de la revendication 12, dans lequel lesdits blocs sont codés différemment en changeant un code convolutionnel pour chaque bloc retransmis.
17. Système de communication de la revendication 9, dans lequel ledit mode de transmission ARQ comprend une adaptation de liaison.
18. Système de communication de la revendication 15, dans lequel ledit mode de transmission ARQ comprend une adaptation de liaison.
19. Système de communication de la revendication 13, dans lequel un taux de codes est modifié en changeant ledit modèle de perforation.
20. Système de communication de la revendication 10, dans lequel ledit mode de transmission ARQ comprend une adaptation de liaison et dans lequel des taux de codes différents pour l'adaptation de liaison ainsi que des versions codées différentes pour une redondance incrémentale sont créés en perforant le même code convolutionnel.
21. Procédé de réception d'un bloc à partir d'un transmetteur comprenant le fait :
- de stocker une pluralité de schémas de codage suivant un ordre prédéterminé ;
- de recevoir, au niveau d'un récepteur, ledit bloc et un ou plusieurs blocs retransmis à partir dudit transmetteur ; et
- de traiter individuellement, au niveau du récepteur, chacun desdits un ou plusieurs blocs retransmis en utilisant un schéma de codage différent correspondant à l'ordre prédéterminé de ladite pluralité de schémas de codage,
- caractérisé en ce que**
- ledit bloc et chacun desdits un ou plusieurs blocs retransmis sont codés en utilisant ladite pluralité de schémas de codage et sont optimisés pour être tous deux individuellement décodables, pour une réception en mode ARQ sans utilisation d'une redondance incrémentale, et de manière combinée, pour une réception en mode ARQ avec utilisation d'une redondance incrémentale.
22. Procédé de la revendication 21, dans lequel ledit mode ARQ est un mode ARQ hybride de type I.
23. Procédé de la revendication 21, dans lequel chacun desdits schémas de codage utilise un modèle de perforation différent.
24. Procédé de la revendication 21, dans lequel chacun desdits schémas de codage utilise un code convolutionnel.
25. Procédé de transmission d'un bloc à un récepteur comprenant le fait :
- de stocker une pluralité de schémas de codage suivant un ordre prédéterminé ;
- de traiter individuellement, au niveau d'un transmetteur, chacun d'un ou de plusieurs blocs à

retransmettre en utilisant un schéma de codage différent correspondant à l'ordre prédéterminé de ladite pluralité de schémas de codage, de transmettre, au niveau du transmetteur, ledit bloc et un ou plusieurs blocs retransmis audit récepteur ; et

caractérisé en ce que

ledit bloc et chacun desdits un ou plusieurs blocs retransmis sont codés en utilisant ladite pluralité de schémas de codage et sont optimisés pour être tous deux individuellement décodables, pour une réception en mode ARQ sans utilisation d'une redondance incrémentale, et de manière combinée, pour une réception en mode ARQ avec utilisation d'une redondance incrémentale.

26. Procédé de la revendication 25, dans lequel ledit mode de ARQ est un mode ARQ hybride de type I.

27. Procédé de la revendication 25, dans lequel chacun desdits schémas de codage utilise un modèle de perforation différent.

28. Procédé de la revendication 25, dans lequel chacun desdits schémas de codage utilise un code convolutionnel.

29. Procédé de transmission et de réception de blocs dans un système de communication comprenant le fait :

de transmettre, en accord avec le procédé de la revendication 25, ledit bloc en un mode de transmission ARQ ;

caractérisé en ce qu'il comprend en outre le fait :

de recevoir, en accord avec le procédé de la revendication 21, lesdits blocs, au niveau d'un premier récepteur, fonctionnant dans un premier mode de réception ; et de recevoir, en accord avec le procédé de la revendication 21, lesdits blocs, au niveau d'un deuxième récepteur, fonctionnant dans un deuxième mode de réception, dans lequel ledit premier mode de réception est un mode ARQ n'utilisant pas de redondance incrémentale et ledit deuxième mode de réception est un mode ARQ utilisant une redondance incrémentale, dans lequel ledit mode de transmission ARQ utilise une redondance incrémentale, dans lequel des blocs retransmis sont codés différemment d'un bloc transmis original, en utilisant des schémas de codage successifs optimisés pour être tous deux individuellement décodables et de manière combinée.

30. Procédé de la revendication 29, dans lequel ledit mode de transmission ARQ utilise une redondance incrémentale, dans lequel des blocs retransmis sont codés différemment d'un bloc transmis original, et dans lequel chaque bloc retransmis peut être décodé de manière indépendante.

31. Procédé de la revendication 29, dans lequel ledit premier mode de réception est un mode ARQ hybride de type I et ledit deuxième mode de réception est un mode ARQ hybride de type II.

32. Procédé de la revendication 29, dans lequel ledit mode de transmission ARQ est un mode ARQ hybride de type II adapté pour retransmettre des blocs qui sont codés différemment d'un bloc transmis à l'origine, et dans lequel chaque bloc retransmis peut être décodé de manière indépendante.

33. Procédé de la revendication 30, dans lequel lesdits blocs sont codés différemment en changeant un modèle de perforation pour chaque bloc retransmis.

34. Procédé de la revendication 30, dans lequel lesdits blocs sont codés différemment en changeant un code convolutionnel pour chaque bloc retransmis.

35. Procédé de la revendication 32, dans lequel lesdits blocs sont codés différemment en changeant un modèle de perforation pour chaque bloc retransmis.

36. Procédé de la revendication 32, dans lequel lesdits blocs sont codés différemment en changeant un code convolutionnel pour chaque bloc retransmis.

37. Procédé de la revendication 29, dans lequel ledit mode de transmission ARQ comprend une adaptation de liaison.

38. Procédé de la revendication 35, dans lequel ledit mode de transmission ARQ comprend une adaptation de liaison.

39. Procédé de la revendication 33, dans lequel un taux de codes est modifié en changeant ledit modèle de perforation.

40. Procédé de la revendication 30, dans lequel ledit mode de transmission ARQ comprend une adaptation de liaison et dans lequel des taux de codes différents pour une adaptation de liaison ainsi que des versions codées différentes pour une redondance incrémentale sont créés en perforant le même code convolutionnel.

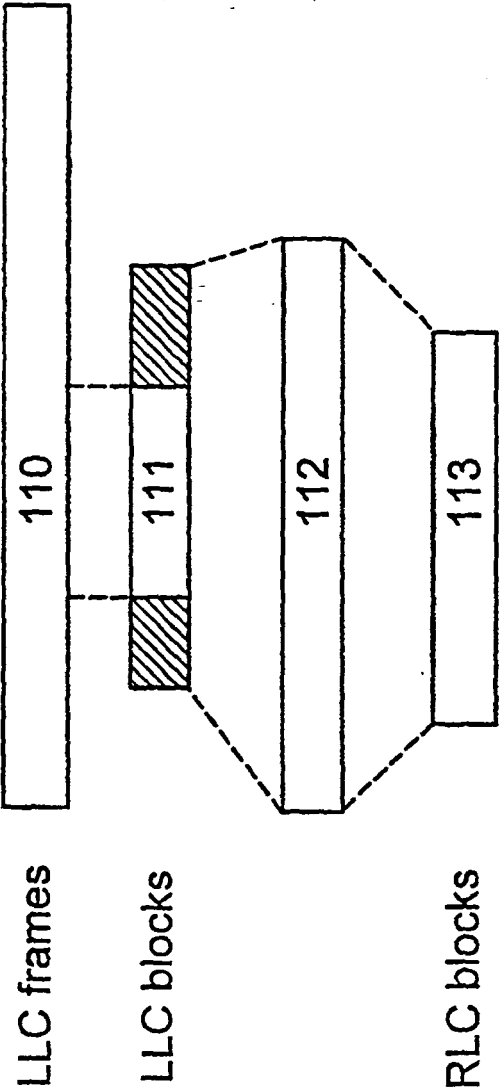
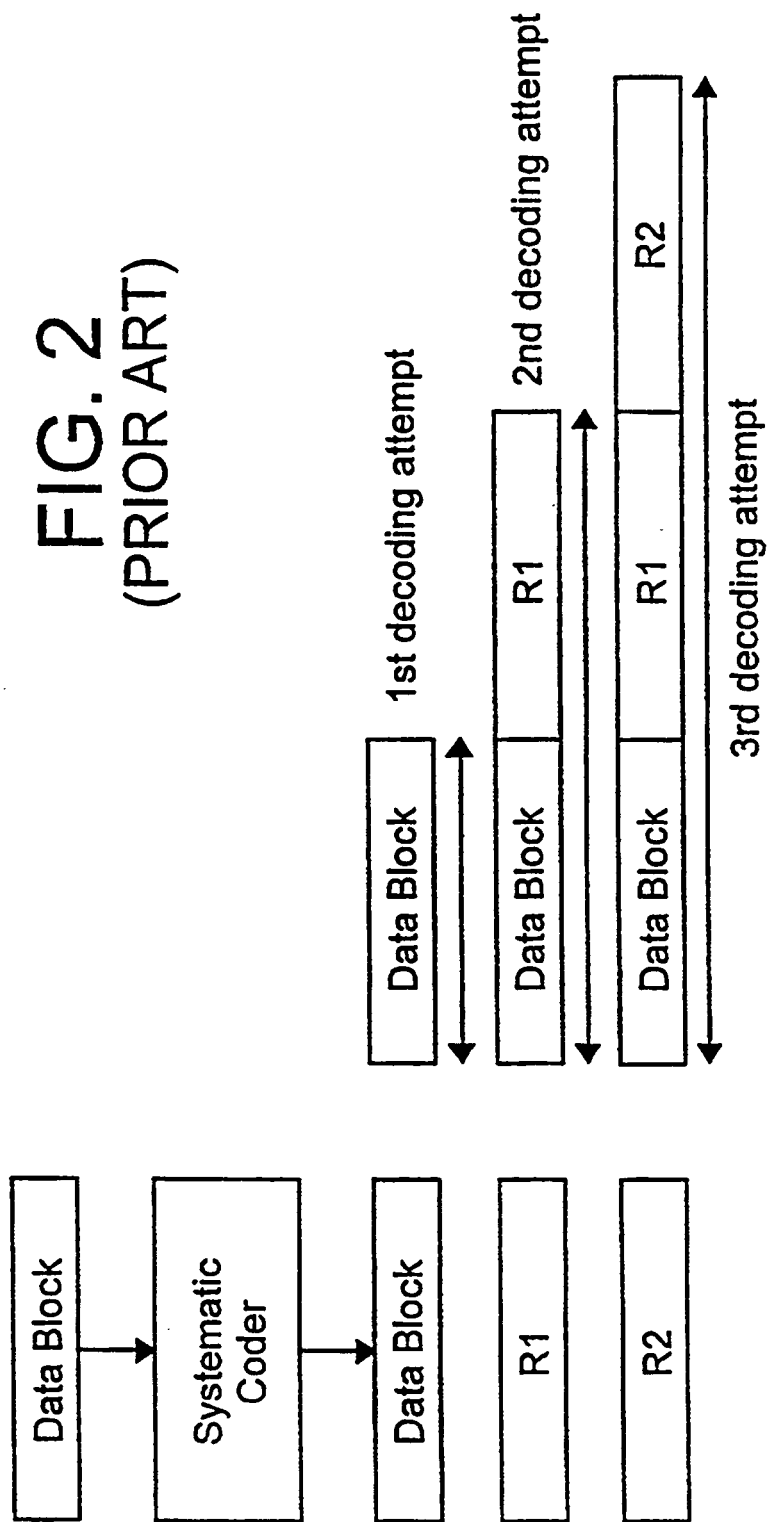


FIG. 1
(PRIOR ART)



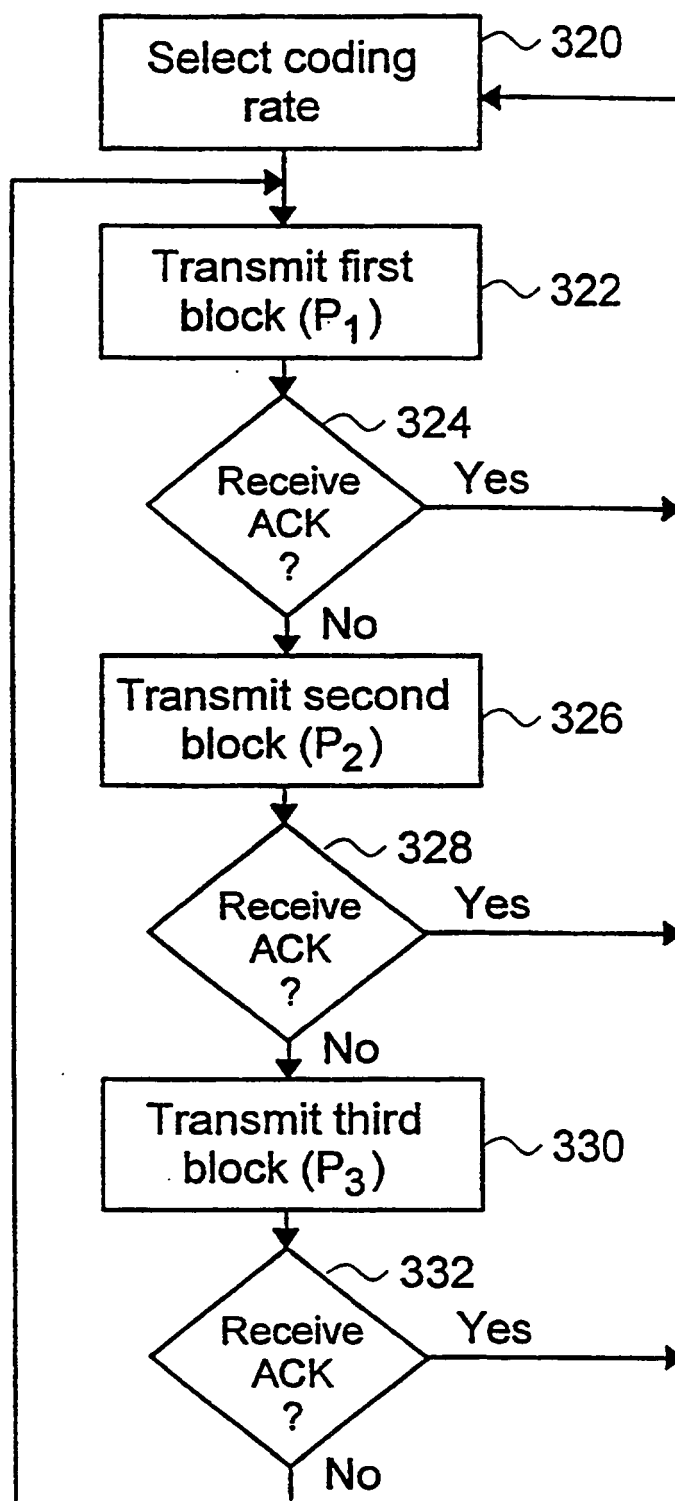


FIG. 3

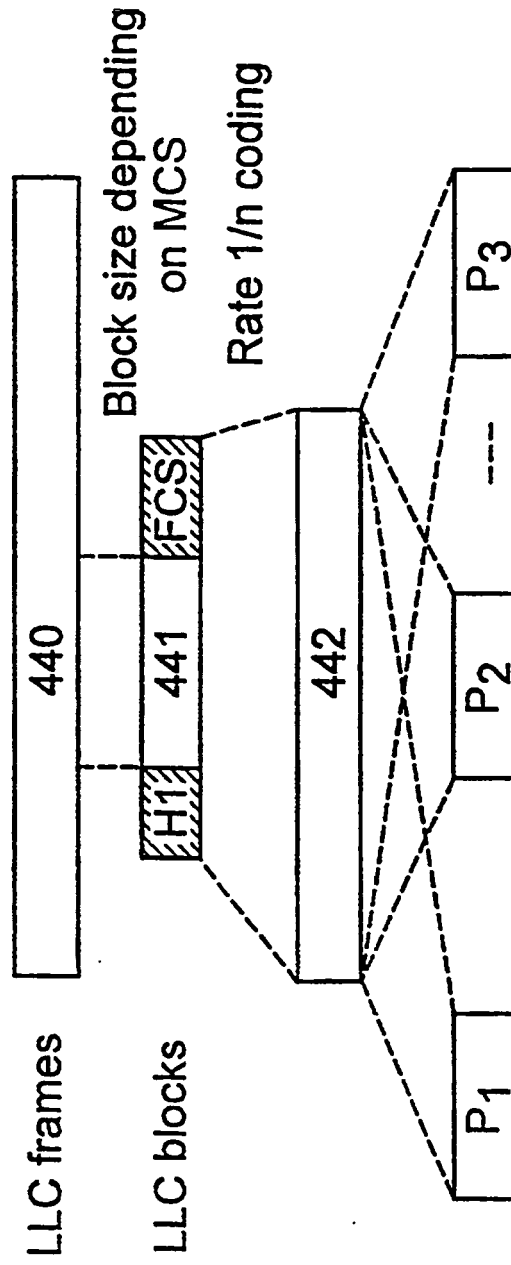


FIG. 4

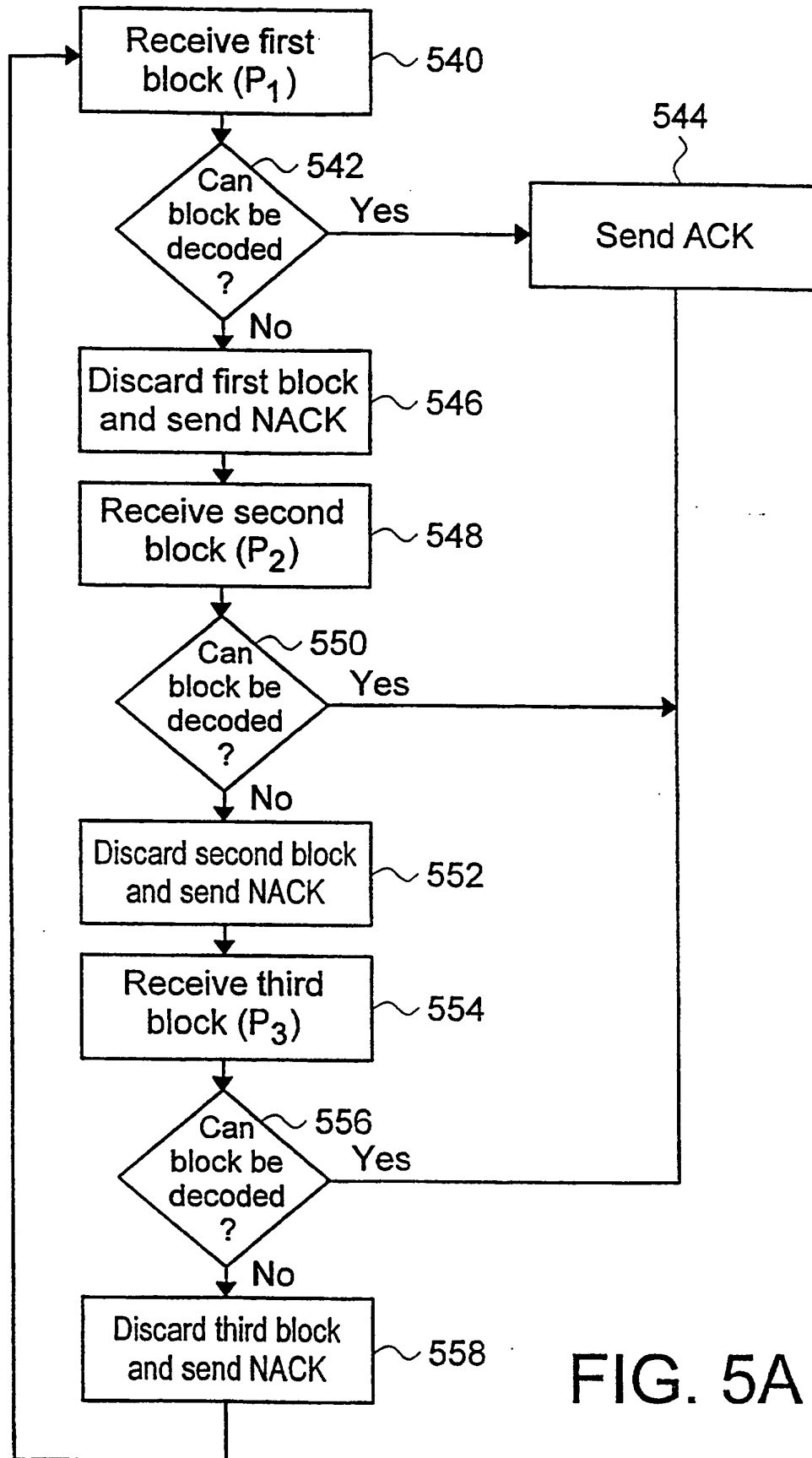


FIG. 5A

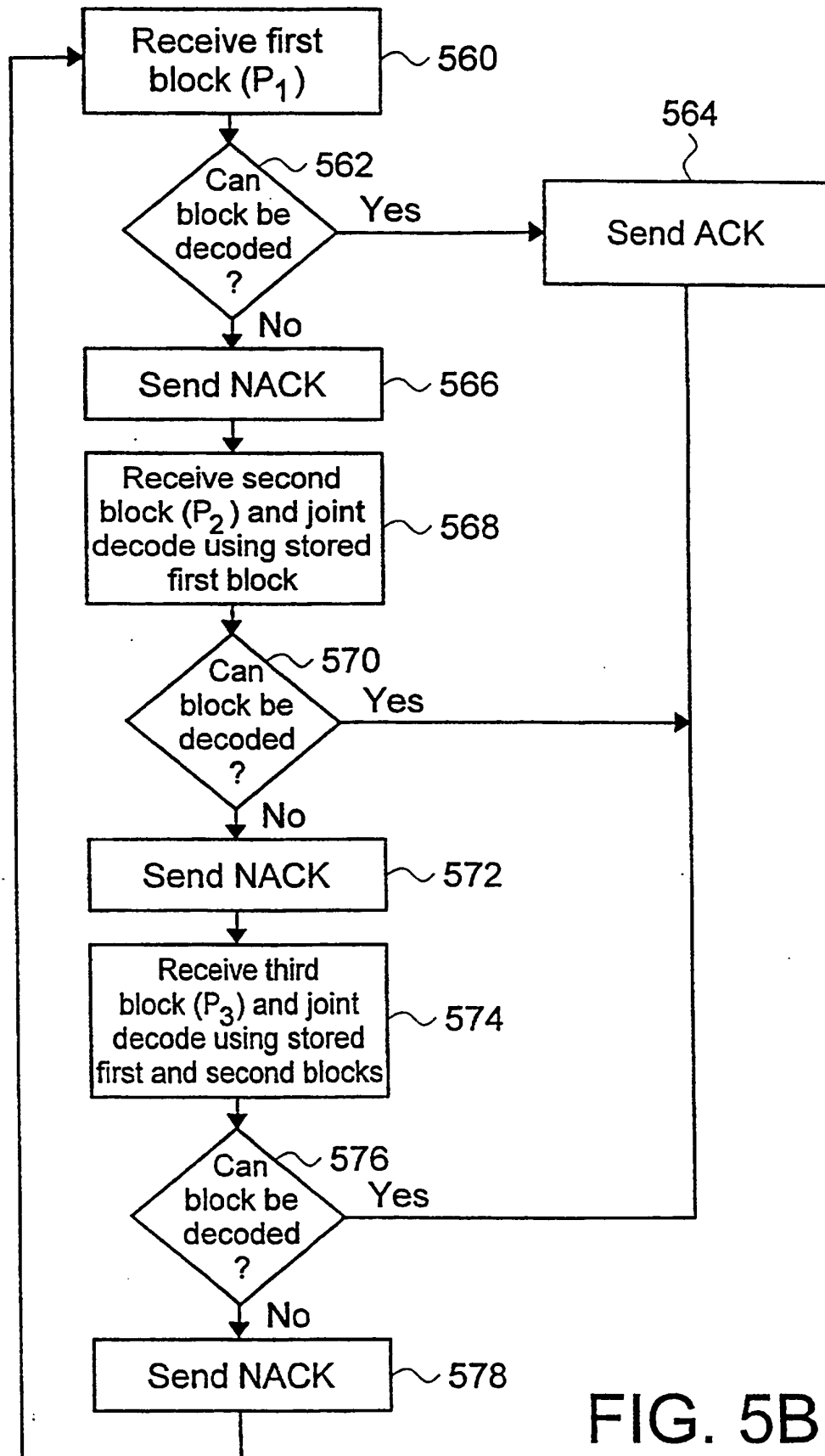


FIG. 5B

Scheme	Modulation	Maximum Rate [kbps]	Code Rate	Header Code Rate	Blocks per 20 ms	Family
MCS-8	8PSK	59.2	1.0	0.35	2	A
MCS-7		44.8	0.76	0.35	2	B
MCS-6		29.6	0.49	1/3	1	A
MCS-5		22.4	0.37	1/3	1	B
MCS-4	GMSK	17.6	1.0	1/2	1	C
MCS-3		14.8	0.80	1/2	1	A
MCS-2		11.2	0.66	1/2	1	B
MCS-1		8.8	0.53	1/2	1	C

FIG. 6A

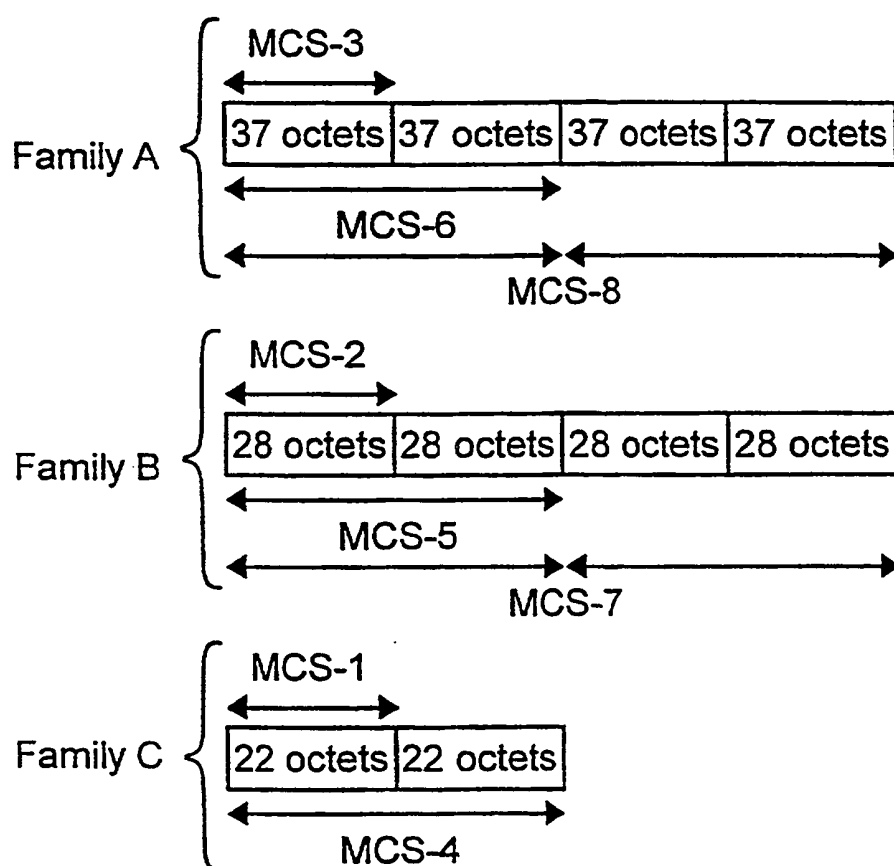


FIG. 6B

FIG. 7A

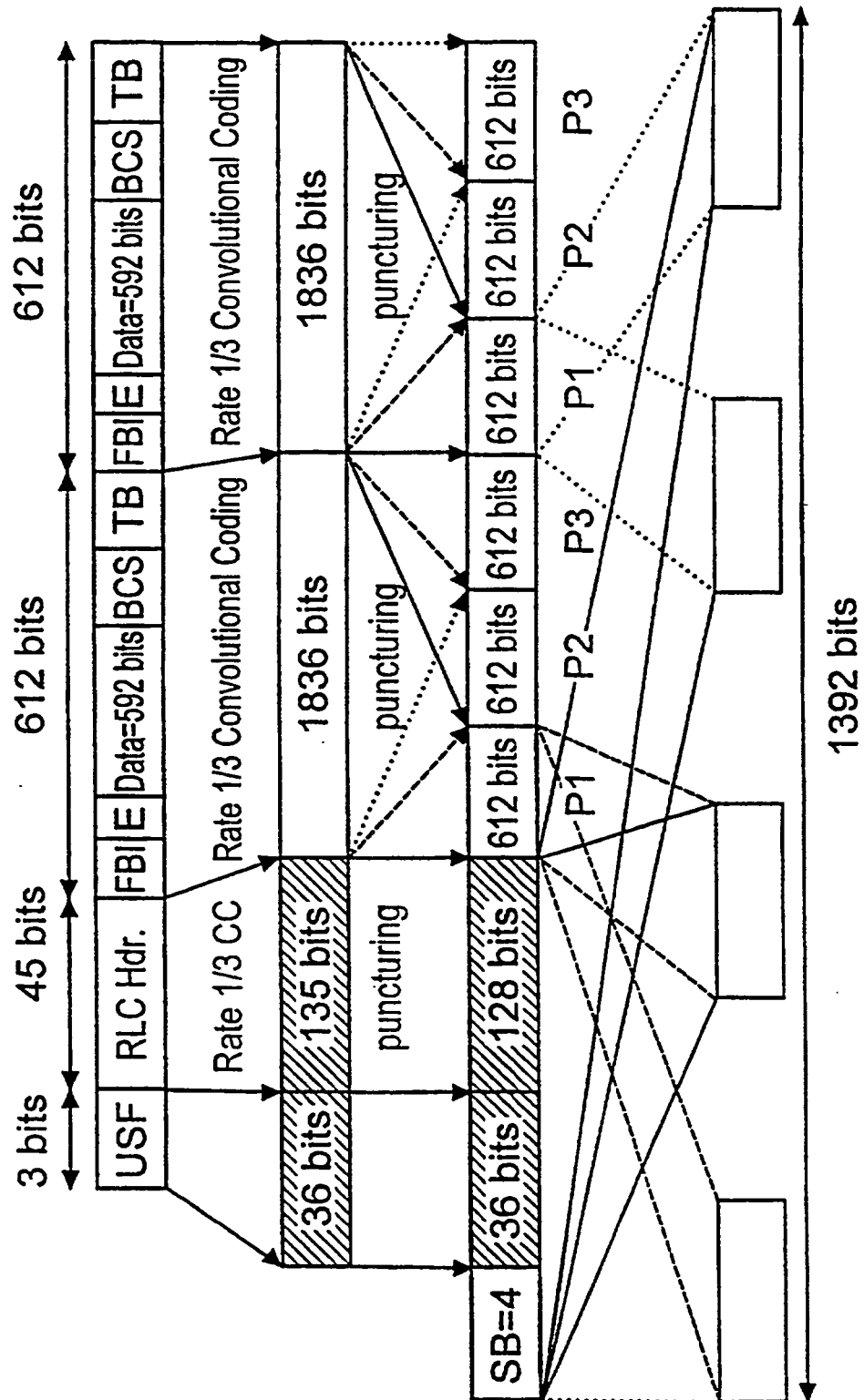
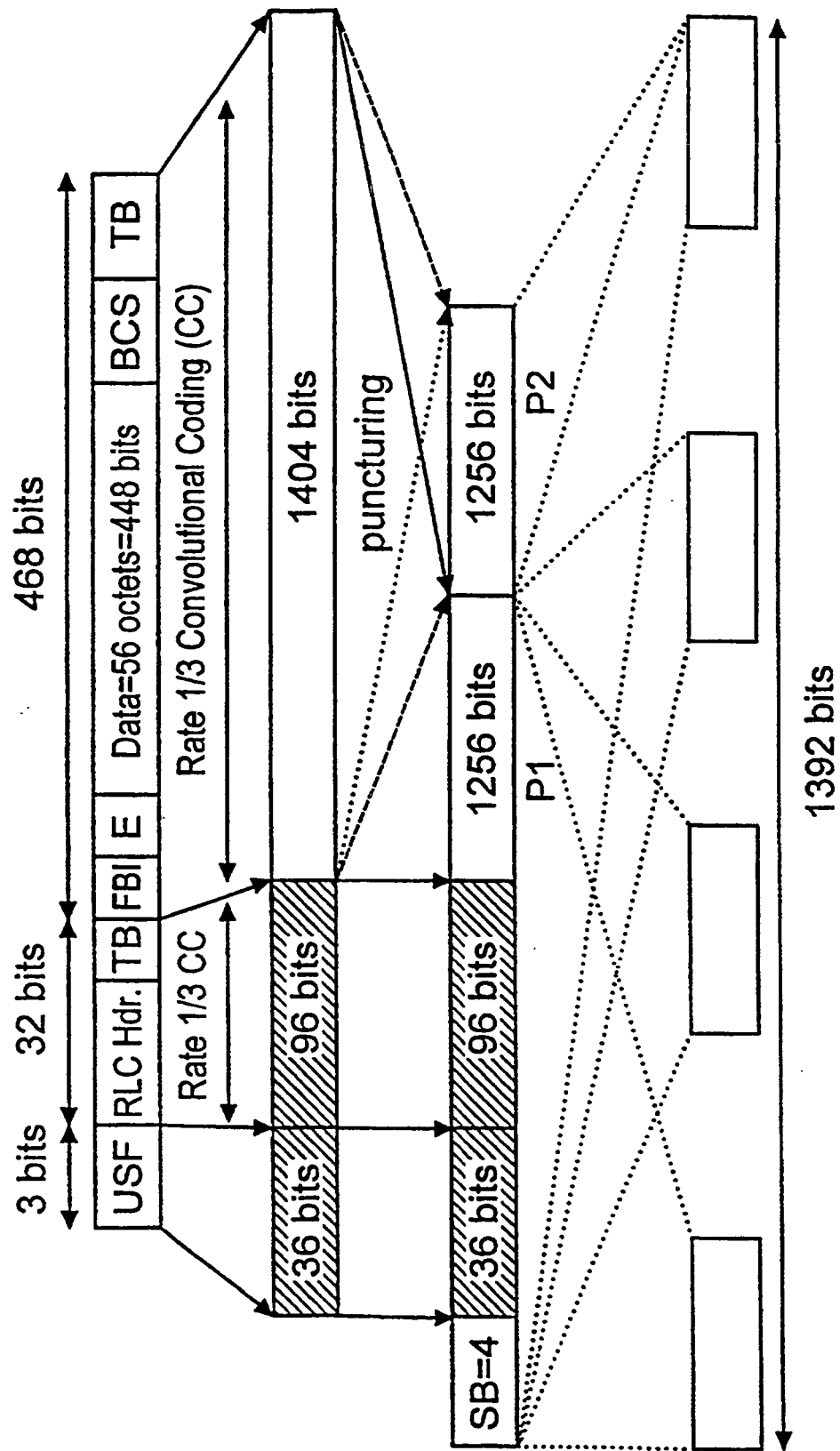


FIG. 7B



REFERENCES CITED IN THE DESCRIPTION

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